

# Biofuels Research at NREL

*Developing a clean, domestic transportation fuel*

Researchers at the National Renewable Energy Laboratory are developing alternative transportation fuels that could dramatically improve our environment, economy, and energy security. These “biofuels” offer a clean, cost-competitive alternative to gasoline, and could help reduce U.S. reliance on imported oil and create a major new industry.

## *Biofuels*

Biofuels are made from renewable biomass resources such as grasses, trees, trash, and waste from the agricultural and forestry industries. Biofuels include ethanol, methanol, biodiesel and additives for reformulated gasoline.

Ethanol, the most widely used biofuel, is added to 9 percent of the nation’s gasoline to improve vehicle performance and reduce air pollution. Ethanol is made using a process similar to brewing beer—biomass material is converted into sugars, the sugars fermented into ethanol, and the ethanol distilled into its final form. More than 1.5 billion gallons of ethanol are used in the U.S. each year.

## *The Need For Biofuels*

The nation’s 185 million vehicles consume nearly 70 percent of all oil used in the U.S. Half of this oil is imported, creating a \$66 billion oil trade deficit. Experts predict that by 2020, the U.S. will import 74 percent of its oil and have a \$170 billion oil trade deficit. In addition, vehicle emissions account for 60 percent of urban air pollution. Clean, domestically produced biofuels can help address these growing problems.



## *NREL’s Biofuels Research*

NREL’s biofuels research objectives are to develop advanced technologies to make ethanol at costs competitive with gasoline, facilitate commercialization of the technologies, and significantly expand domestic and international use of ethanol.

Researchers are meeting these objectives by developing technologies that improve process efficiency, take advantage of inexpensive feedstock materials, and convert a greater percentage of biomass into ethanol. Researchers also analyze and select—and even genetically engineer—microorganisms best suited to convert biomass into ethanol. The goal is to reduce ethanol costs from \$1.22 per gallon to between 60¢ to 70¢ per gallon within the next decade.

## *Research Accomplishments*

**Increasing ethanol yield from corn**—NREL researchers developed a process to increase ethanol yield from corn by as much as 13 percent. Previously, only the starch in the corn kernel was converted to ethanol. The

new technology also converts the fibrous material in the kernel. New Energy Company of South Bend, Ind., the nation's third largest ethanol manufacturer, is one of the first companies to demonstrate the technology.

**Genetic engineering breakthrough**—NREL researchers genetically engineered a micro-organism that increases the amount of biomass material converted to ethanol by an additional 30 percent.

**Feedstock development**—The ability to convert plant fiber to ethanol has allowed NREL's researchers to explore using a wide range of inexpensive feedstock materials for ethanol production, including trash, agricultural and forestry industry wastes and energy crops (grasses and trees grown specifically for energy production).

**Simultaneous saccharification and fermentation**—This technology converts biomass into ethanol by combining the hydrolysis (the process that breaks biomass down into sugars) and fermentation steps into a single tank. This improves efficiency and significantly reduces capital equipment and operating costs.

## *Benefits*

**Environmental**—Biofuels help alleviate air pollution problems caused by gasoline-fueled vehicles. Biofuels reduce carbon dioxide emissions by more than 90 percent, and compared to gasoline, reduce ozone formation and carbon monoxide emissions.

**Revitalizing rural communities**—Increased biofuels production would create thousands of jobs, increase equipment sales and increase farm incomes by using idle farmland or farmland unsuitable for food crops.

**Domestic and renewable**—Domestically produced biofuels made from renewable resources help reduce the nation's dependence on imported oil and keeps important investment dollars in the U.S.

## *Challenges*

**Cost**—Biofuels are currently more expensive than gasoline. However, advanced technologies could make biofuels as affordable as gasoline in the next decade.

**Infrastructure**—An infrastructure to transport and distribute biofuels as efficiently as gasoline has not been developed.

## *Potential*

The U.S. has an abundance of renewable biomass resources. We send more than 200 million tons of waste to landfills each year, and have over 50 million acres of idle farmland—land ideally suited for growing energy crops. If fully utilized, these resources could produce enough biofuels to power all our cars, trucks, and buses. While this level of market penetration isn't realistic in the foreseeable future, biomass resources could eventually provide over 50 percent of our transportation fuel.